

MAF/TIGER Enhancements Program



Presentation to the Washington Transportation Framework Partners

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MAF/TIGER Enhancements Program



America's population is
ever-moving,
ever-changing.



MAF/TIGER Enhancements Program



correct

data accuracy and
geographic location

governmental unit, census tract, census block

reliable

data accuracy and
geographic location

governmental unit, census tract, census block

MAF/TIGER Enhancements Program



BRINGING MAF/TIGER into the
21ST CENTURY...

NEW TOOLS . . .

NEW TECHNOLOGIES . . .

NEW CHALLENGES

What is TIGER?

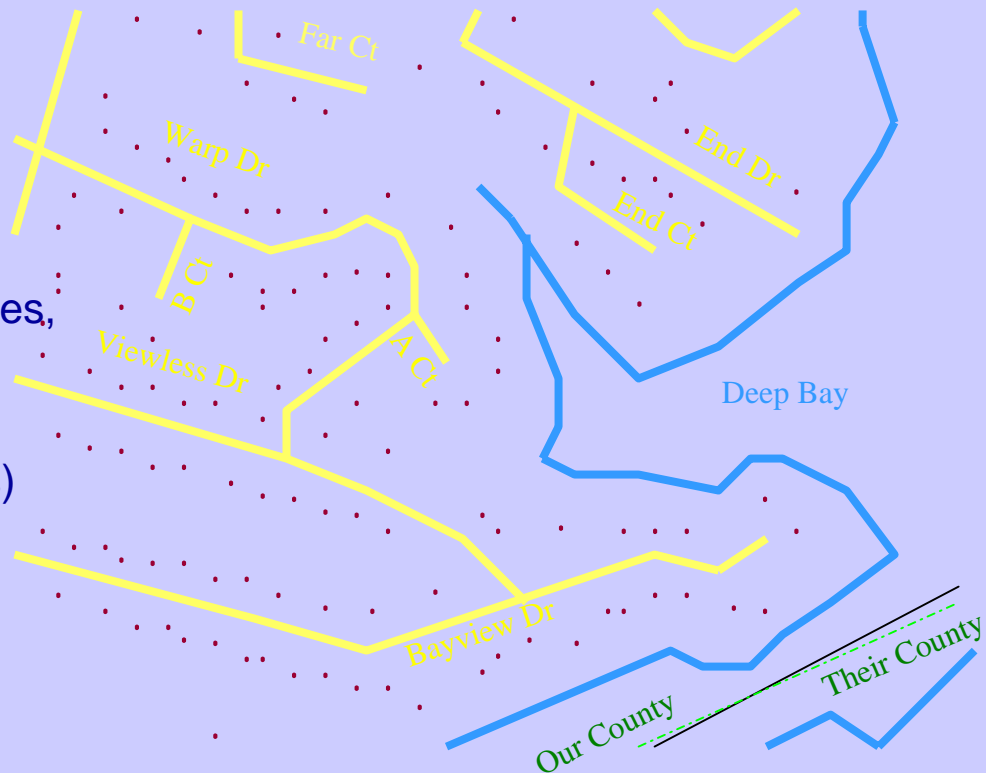
Topologically Integrated Geographic Encoding and Referencing



A street center-line “digital map” (geographic data base) of the entire United States, Puerto Rico, and the associated Island Areas

TIGER Content

- Street center-lines and their names
- Lakes, streams, and their names
- Railroads
- Geographic entity boundaries, names, and codes (for governmental units, census tracts, census blocks, etc.)
- Housing unit locations (some areas)
- Key geographic locations (for airports, schools, etc.)
- ZIP Codes and address ranges (for streets with city-style addresses)



What is the MAF?

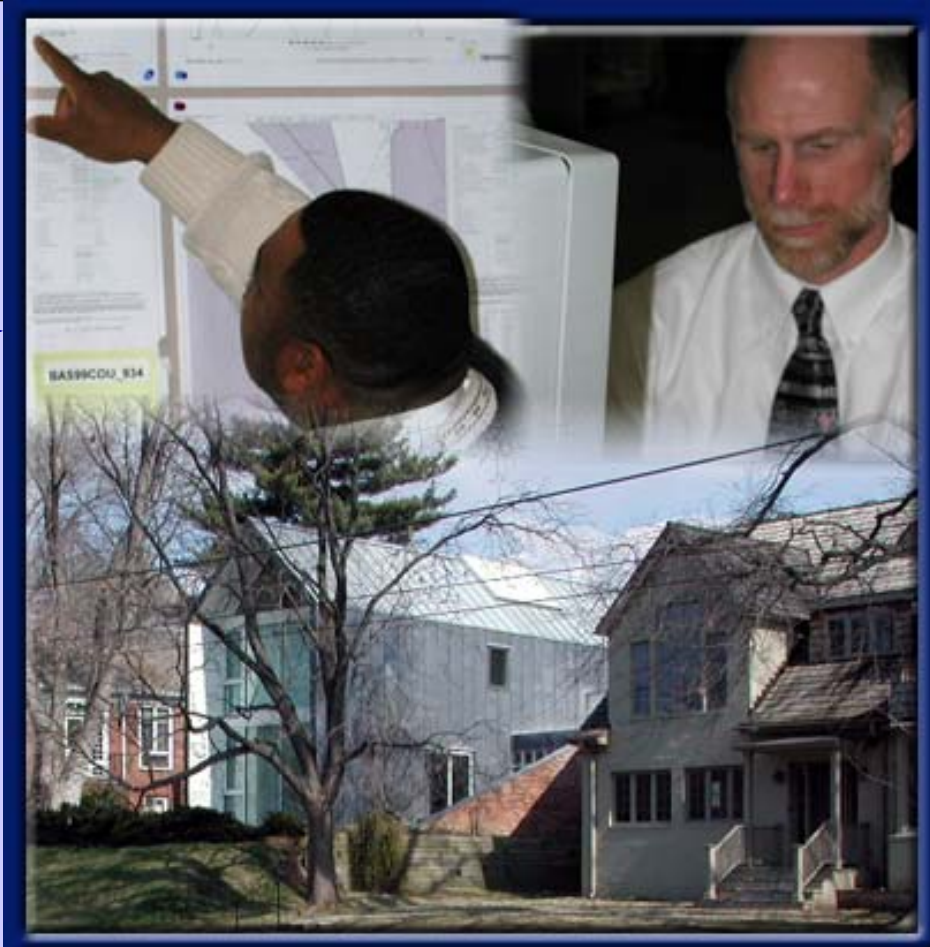
Master Address File



An accurate and up to date inventory of all known living quarters in the United States, Puerto Rico, and associated Island Areas

The content of the MAF is:

- Mailing address, if one exists
- Descriptive address, if no mailing address is known
- Census geographic location
- Source and history data



Title 13 requires that all addresses/locations be kept confidential

Major MAF/TIGER Functions



Mapping

- Maps for data user reference
- Maps (and address lists) for field operations, such as Block Canvassing

Geocoding

- Determines geographic location of every structure
- Identifies areas that need MAF/TIGER update

Data Products

- Provides names and codes of entities for data tabulation
- TIGER/Line helps fuel the commercial GIS industry

Major MAF/TIGER Issues

Location Information of Mixed/Variable Accuracy



Large, non-uniform differences in location accuracy exist in a relatively small area, and no detailed quality measures document the extent of street and address errors



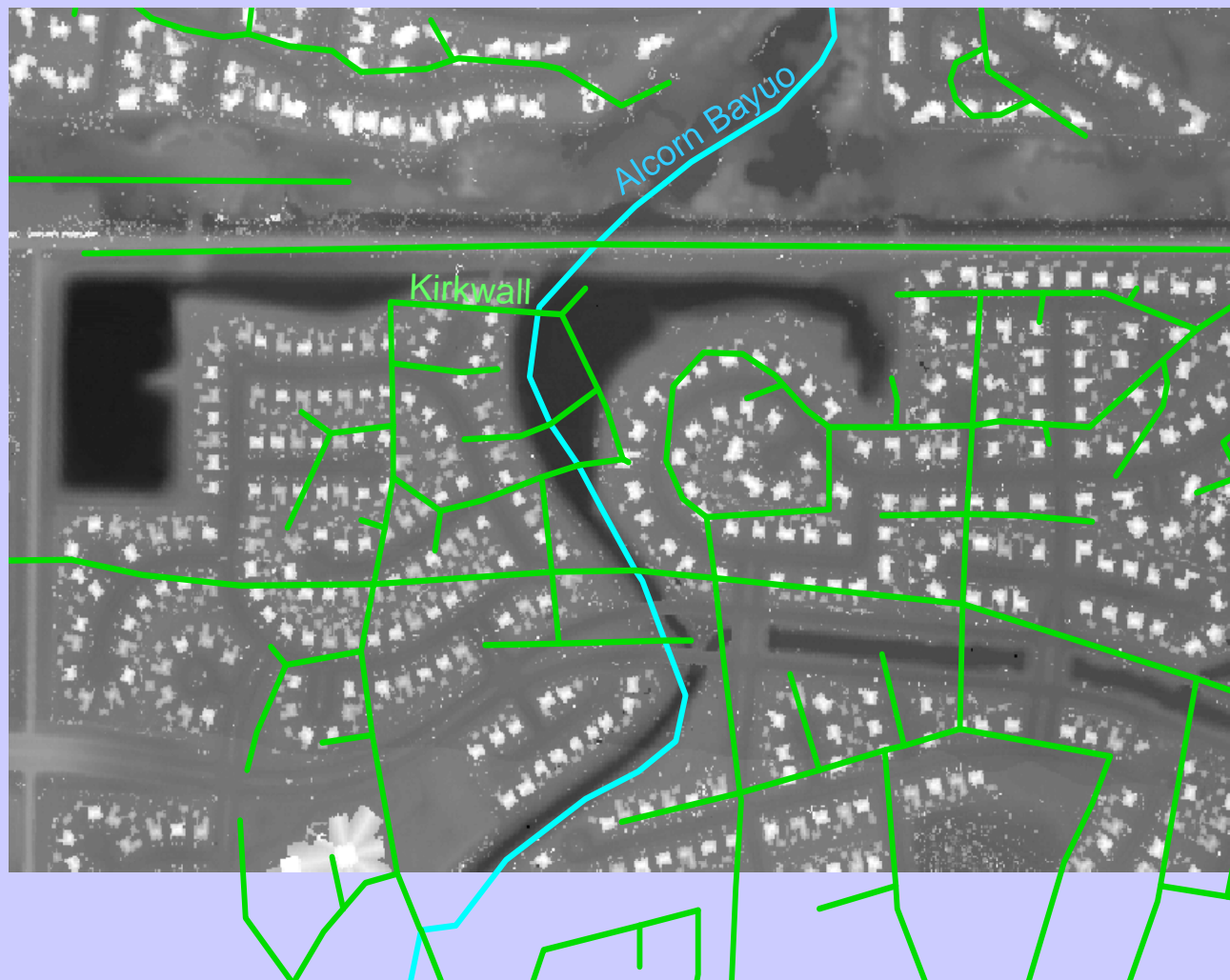
Major MAF/TIGER Issues

“Truth” contradicts existing Feature Topology



Stream mistakenly crosses several streets to form “census blocks” that do not exist

The problem is how to show the true situation correctly in the future, while maintaining an historical link to Census 2000 block numbers

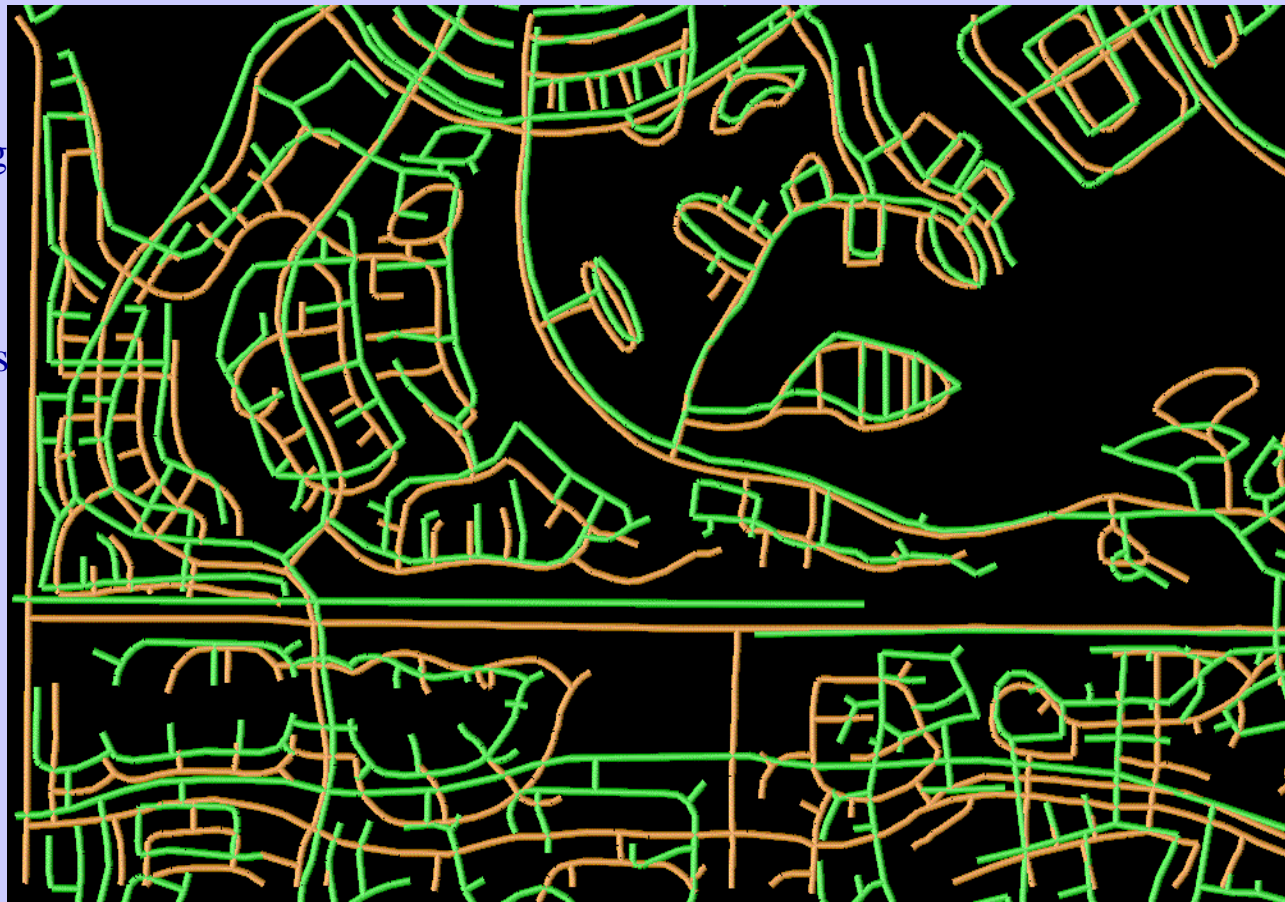


Major MAF/TIGER Issues

Roads in TIGER/housing units in MAF not in “true” geographic locations



Original TIGER Data and State/Local/Tribal Roads



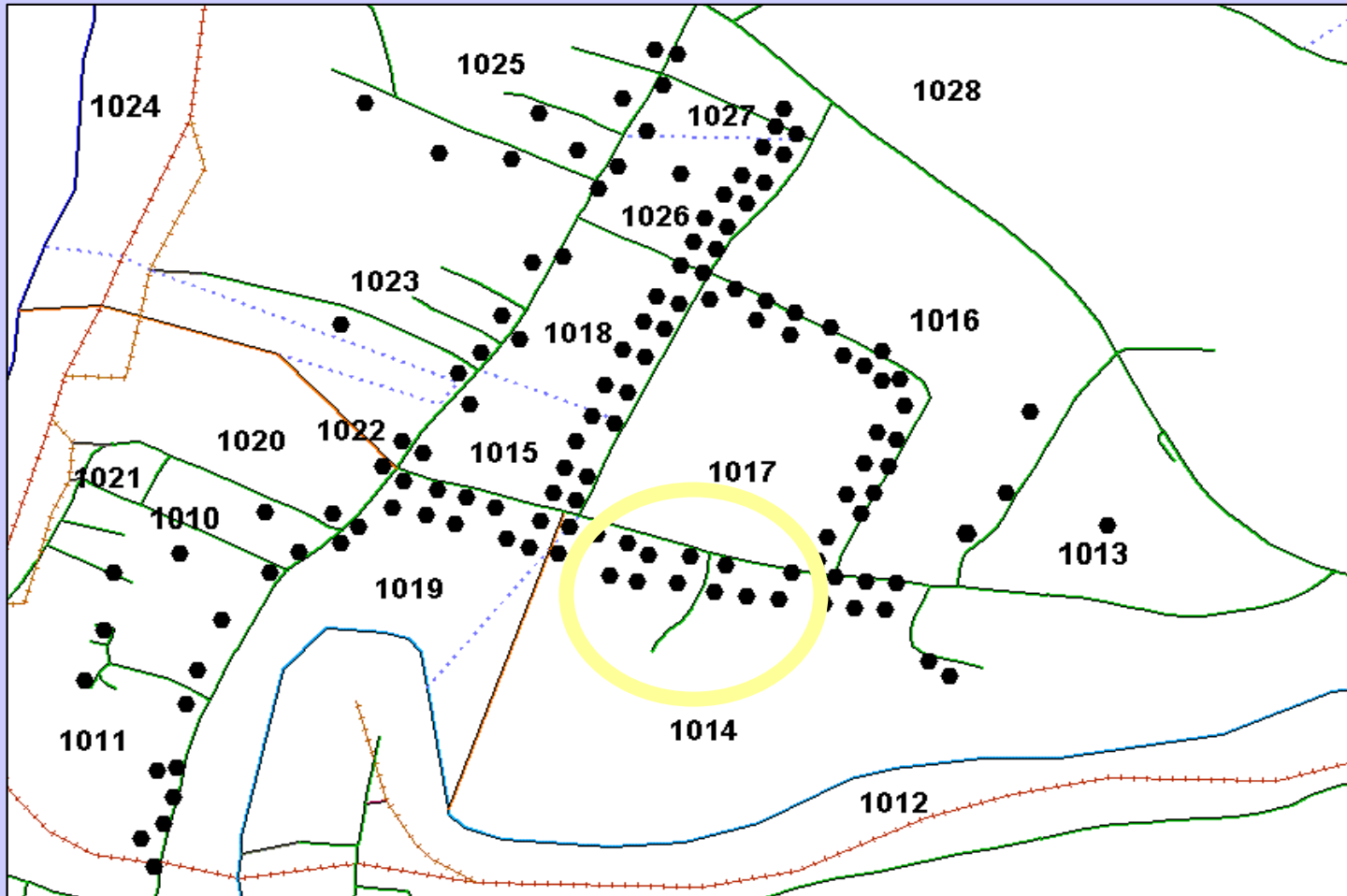
Inaccurate MAF/TIGER locations constrain efforts to exchange highly accurate location information with willing geographic partners that have GIS files – and preclude adoption as the road and boundary layers in **The National Map**

In addition, the “home grown” MAF/TIGER processing environment makes development of Web-based review and update processes more cumbersome

— TIGER
— Local GIS

Major MAF/TIGER Issues

Inaccurate locations preclude adopting GPS locational technology for the American Community Survey and the 2010 Census until MAF/TIGER has locations corrected



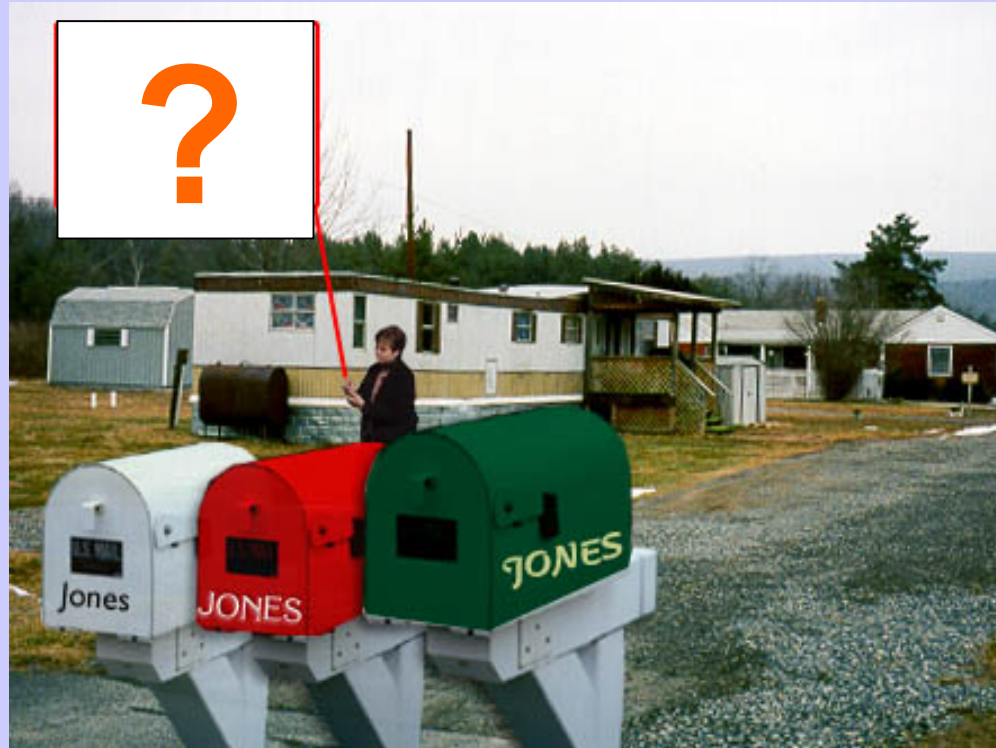
Good GPS structure locations over mislocated MAF/TIGER street centerlines would put many houses on the wrong side of the street and, therefore, in the wrong census block

Major MAF/TIGER Issues

No process currently exists to update MAF/TIGER with new addresses (and the new streets along which many are located) in areas that do not have (or use) city-style addresses for U.S. Postal Service mail delivery



In areas that will not benefit from the twice-yearly “refreshes” of MAF/TIGER with address and street updates from the USPS’s Delivery Sequence File, because the existing housing units do not have (or use) addresses that are “city-style,” the Census Bureau has no automated update source



MAF/TIGER Enhancements Program



21st Century MAF/TIGER Enhancements

- Improved address and map accuracy
- More effective geographic partnership programs
- Leading to more effective/lower cost 2010 Census and household survey operations

Five Objectives for the MAF/TIGER Enhancements Program



OBJECTIVE 1:

MAF/TIGER Accuracy Improvement Project (MTAIP)

- **Correct (in TIGER) the locations of streets and other map features** used for orientation, and by state/local/tribal governments and private sector firms that have GIS files for alignment, as well as the location of **every boundary used for tabulation** of decennial census and household survey data.
- **Correct (in MAF) the location every housing unit and every group qtrs** from which the decennial census and the household surveys collect data, as well as the location of every business/institutional establishment at which respondents work
- **Implement an effective change detection methodology** to document the location of every new street, new housing unit, new group quarters, as well as the location of every new business/institutional establishment at which respondents work.

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Primary Strategy

Use Highly Accurate State/Local/Tribal GIS files, Where Available

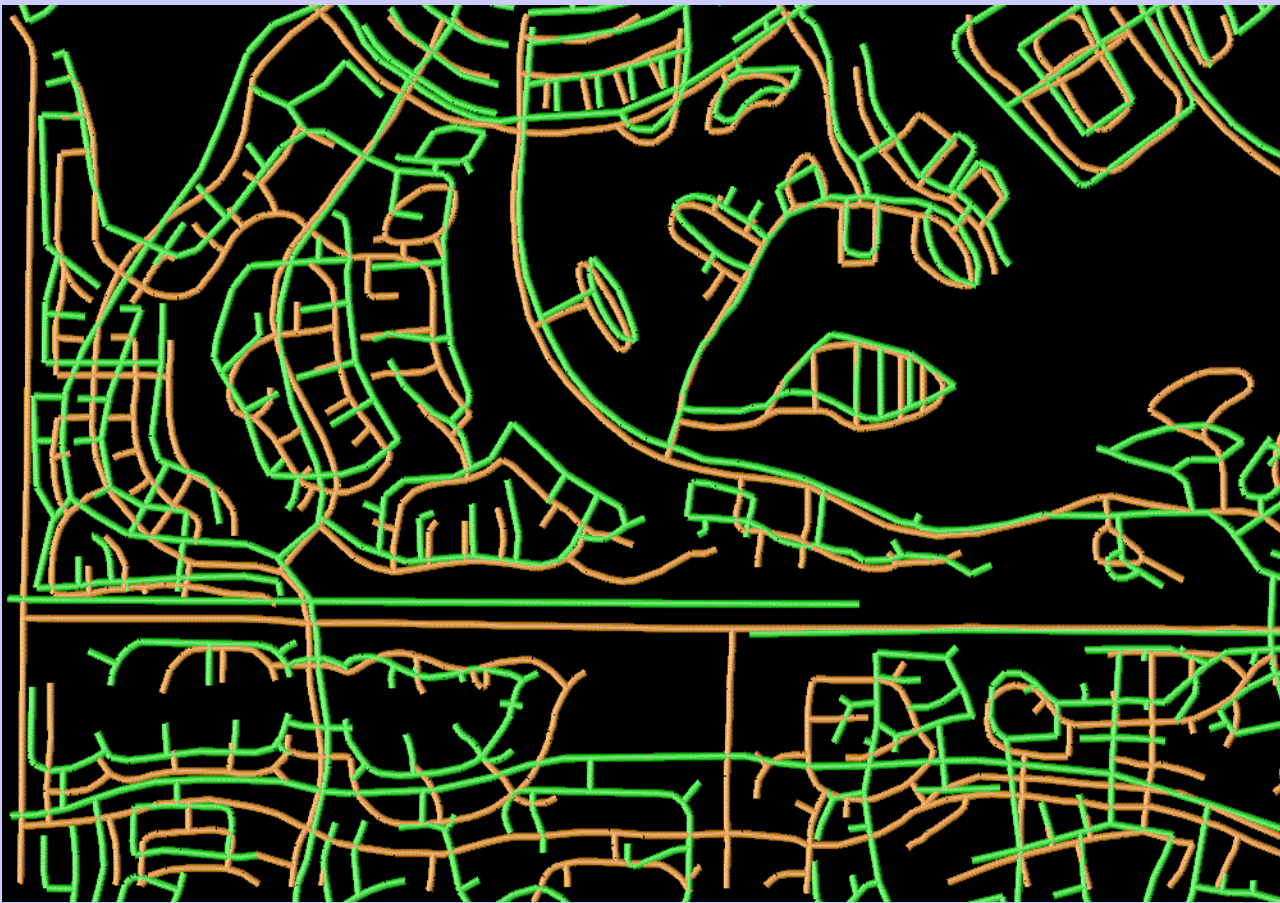


Original TIGER Data and State/Local/Tribal Roads

Highly accurate GIS file are available for hundreds of local/tribal governments.

These files provide the most effective information to correct MAF/TIGER locations, and often are a good source for new streets and addresses.

— TIGER
— Local GIS



Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Secondary Strategy

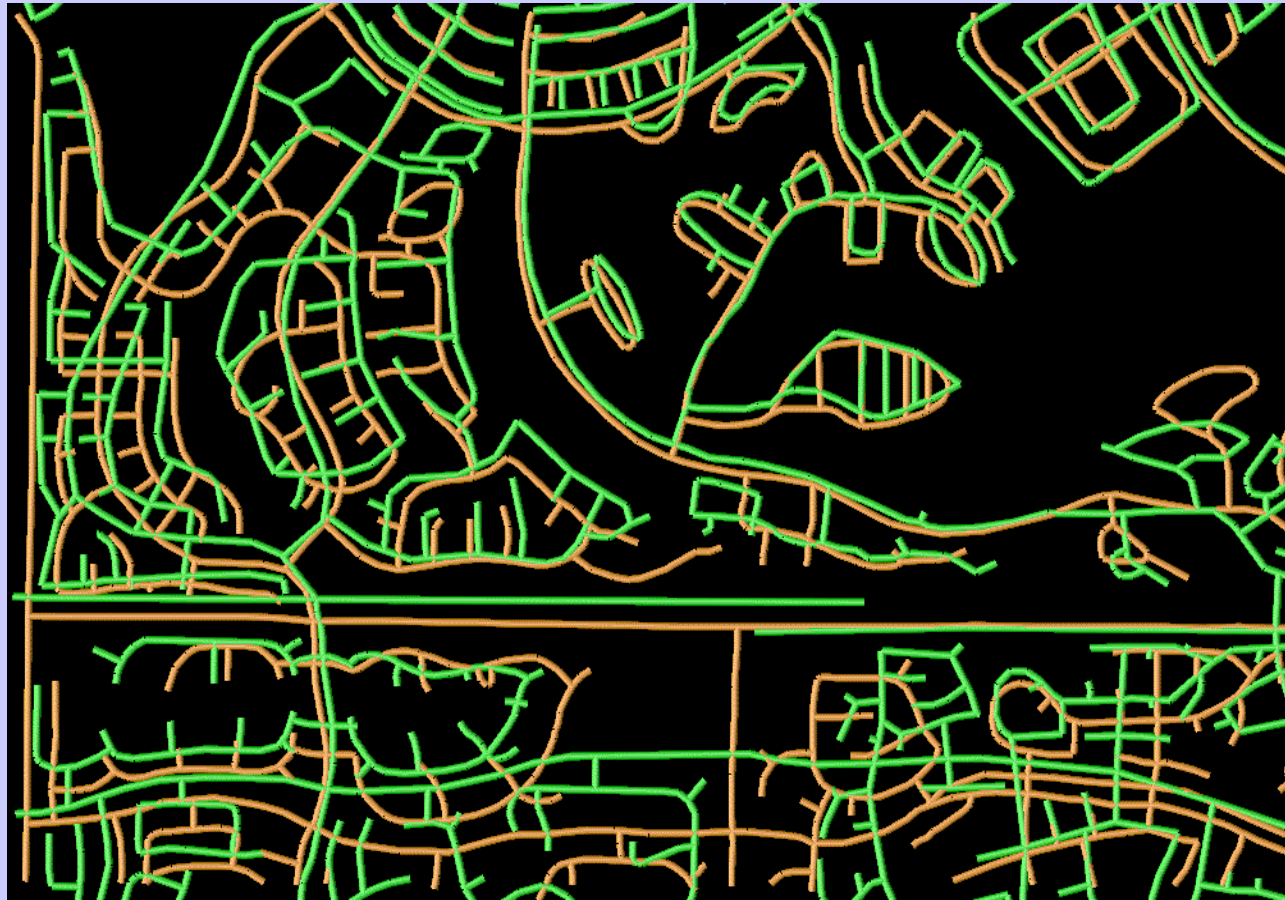
Use Highly Accurate Private Sector GIS files, Where Available



Original TIGER Data and Private Sector File

GIS files also exist in the private sector for some areas.

When they are available for MAF/TIGER use without restrictions, they provide an effective source to correct MAF/TIGER locations, and sometimes for new streets and addresses.



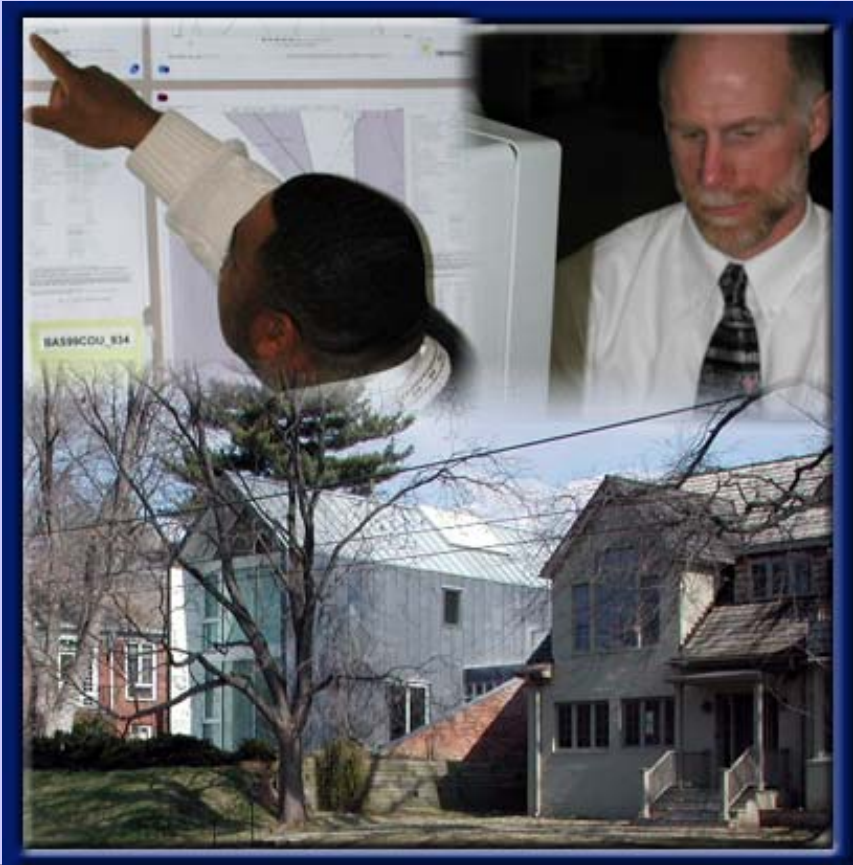
— TIGER
— Private Sector GIS

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)



Where GIS files are not available -- Space based technologies...

...present new opportunities for improving MAF/TIGER locations and detecting changes when GIS files are not available



1 Meter Resolution Imagery



Six Inch Resolution Imagery



GPS

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Aerial photos and satellite images...

...require three processing steps that existing GIS files do not require when they are used to correct MAF/TIGER locations and identify new streets and structures.



Step 1
Gather Raw Imagery



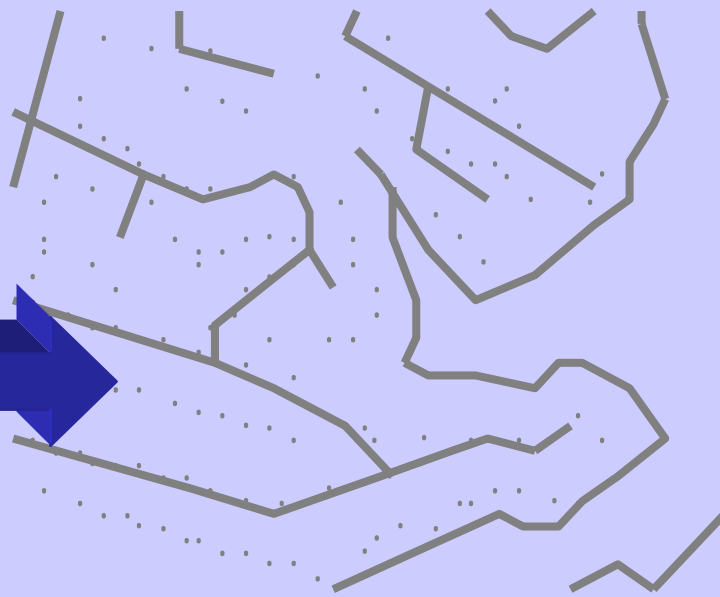
Step 2
Orthorectification

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Aerial photos and satellite images...



Orthorectified Image



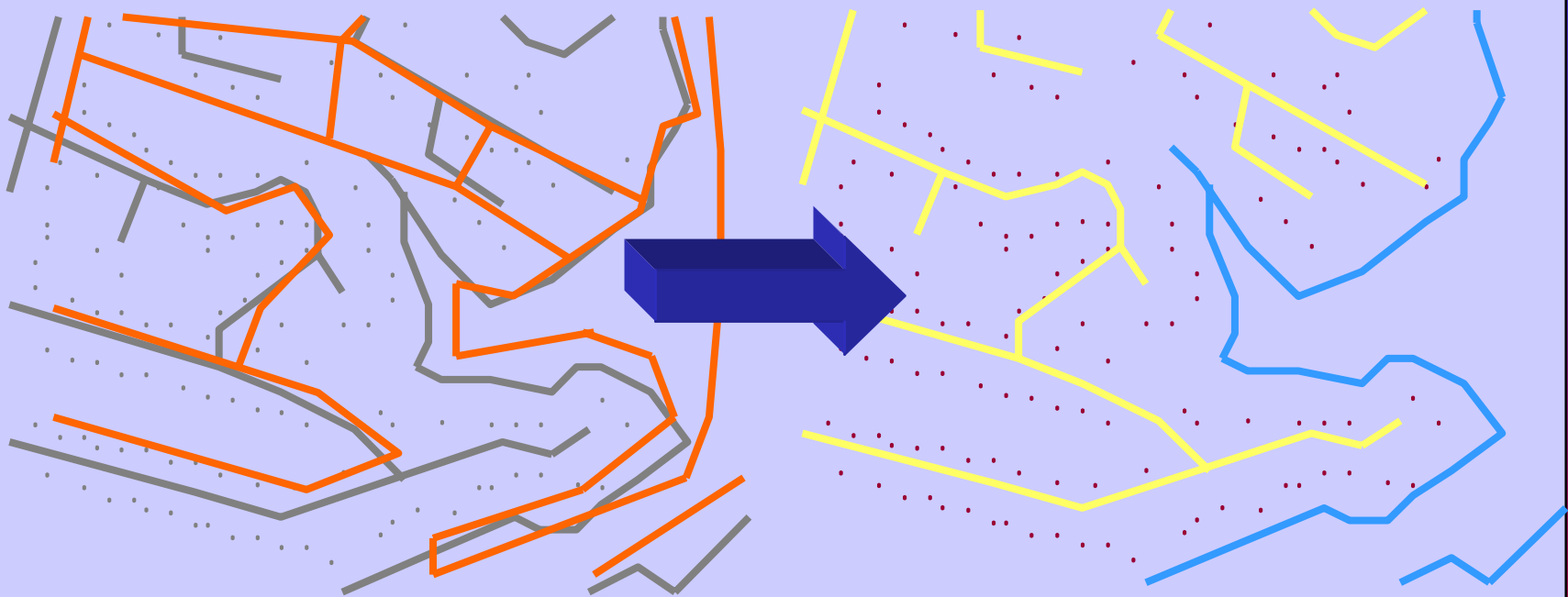
Step 3
Feature Extraction

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

A matching and realignment process...



...is required to use all GIS files and all locations extracted from imagery. The goal is the same – to correct existing MAF/TIGER locations while preserving all other information MAF/TIGER contains about each street and address.



Existing MAF/TIGER superimposed on
accurate location information

MAF/TIGER data are moved
to accurate locations

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

MAF/TIGER Quality Assurance Process



Re-aligned MAF/TIGER locations are checked for accuracy regardless of source – GIS files or imagery.



Quality Assurance, with extensive metadata about the accuracy and completeness of MAF/TIGER



Re-aligned MAF/TIGER data are superimposed over imagery or checked with GPS to verify quality

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Global Positioning Systems (GPS)



GPS provides an alternative method to determine the exact location of a structure, and the correct side of a street (i.e., in the correct census block), especially for limited geographic areas.

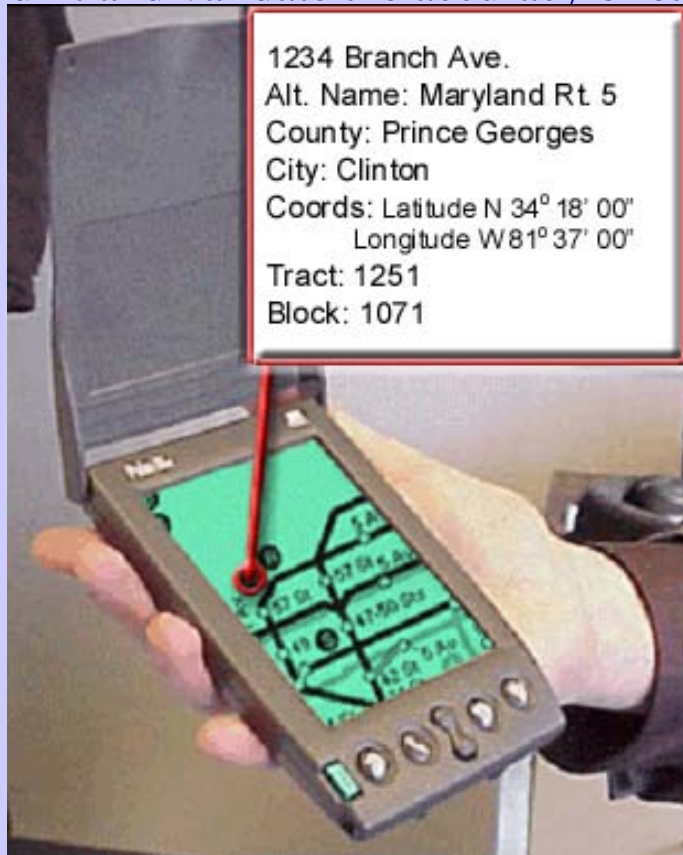
It is an especially valuable technology to perform quality checks on location information from GIS files and location information extracted from imagery.



Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Finding the Correct House...

In the future, correct locations in MAF/TIGER, and devices equipped with GPS receivers, will provide the tools needed by field staff to find the correct housing unit and validate the accuracy of each address.



Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Example: Use of GPS equipped devices



For example, GPS-equipped devices will be able to help field staff identify structures that appear in the MAF two or more times (commonly called “duplicates”) with different addresses.



107 King St.

Latitude N 34° 18' 00"

Longitude W 81° 37' 00"

324 Main St.

Latitude N 34° 18' 00"

Longitude W 81° 37' 00"

GPS can help solve the confusion of “duplicates” by providing an exact location for each address in the MAF

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Recap of Potential Sources



Local Government Files

Use of local government files (where available) – correct the position of geographic features, update postal geography, insert geographic locations of structures into the Database; and change detection.

Private-Sector Files

Use of private-sector files (where available and not restricted) – correct the position of geographic features, update postal geography, insert geographic locations of structures into the database; and change detection.

Off-the Shelf Precision Imagery

Use of high-precision imagery in correcting the locations of the geographic features and structures identified in the TIGER db and can be used for change detection.

GPS Technology

Utilize GPS and mobile computer technology in specialized field operations to collect the geographic location of geographic features and of building structures in areas where local government files are not available.

Custom-Ordered High-Precision Imagery

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)

Change Detection Strategies



When GIS files are not available to provide updates, images from different dates will allow the Census Bureau to quickly find new housing units and new streets.



Five Objectives for the MAF/TIGER Enhancements Program



OBJECTIVE 2:

Develop/deploy a new MAF/TIGER processing environment

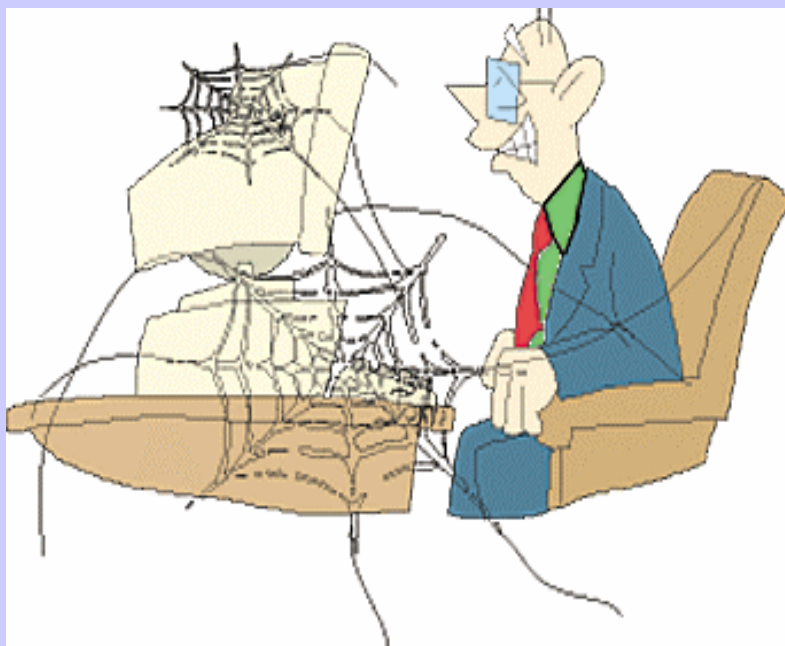
- **Make maximum possible use of COTS and GIS tools**
to allow for rapid development of new applications using staff and contractors who already know these tools.
- **Customize the COTS/GIS tools**
to the minimum extent possible to avoid schedule and cost obstacles when the COTS/GIS packages deploy new versions of their software.
- **Provide the basis for closer integration**
with the many processing environments used by the systems that depend on MAF/TIGER Products and services

Obj. 2 Modern MAF/TIGER Processing Environment

With MAF/TIGER in a commercial database . . .



- Custom software developed in the 1980s
- No commercial alternative available at the time
- Remained in originally designed format and operating design
- \$\$ investment to maintain custom-written software



Current System

New System



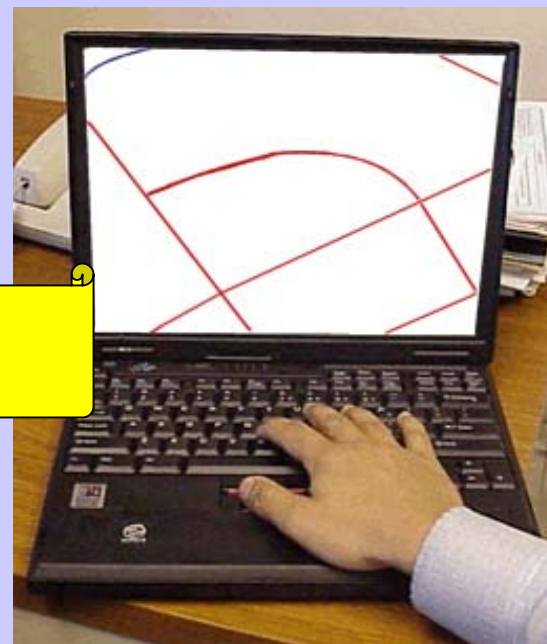
- Geospatial capabilities increased substantially
- Hardware & storage devices less costly
- Less costly than writing and maintaining custom-written software
- Maintenance & testing borne by vendor
- Used by many – data exchange easier

Obj. 2 Modern MAF/TIGER Processing Environment

With MAF/TIGER in a commercial database . . .



Census Bureau staff **AND** State/local/tribal geographic partners



**Happy
Happy**

will be able to work over the web to make updates
concurrently for any geographic area

Obj. 2 Modern MAF/TIGER Processing Environment

Moving towards a COTS environment...



SCENARIO 1:

TIGER, MAF and all other supporting databases would be migrated to a commercially available RDBMS maintaining the current structure and data of the TIGER and MAF.

- ✓ Commercial database versions of existing databases
- ✓ Convert all software applications to operate with the newly designed commercial databases to meet all geographic support needs of the Bureau.

Obj. 2 Modern MAF/TIGER Processing Environment

Moving towards a COTS environment . . .



SCENARIO 1:

TIGER, MAF and all other supporting databases would be migrated to a commercially available RDBMS maintaining the current structure and data of the TIGER and MAF.

SCENARIO 2:

TIGER, MAF and all other supporting databases would be migrated to a commercially available RDBMS, **but the current data structure and content of the geographic databases would be redesigned**

- ✓ Design a new database to meet all geographic support needs of the Bureau
- ✓ Develop a new applications suite from COTS products and custom-written modules

Obj. 2 Modern MAF/TIGER Processing Environment

Moving towards a COTS environment . . .



SCENARIO 1:

TIGER, MAF and all other supporting databases would be migrated to a commercially available RDBMS maintaining the current structure and data of the TIGER and MAF.

SCENARIO 2:

TIGER, MAF and all other supporting databases would be migrated to a commercially available RDBMS, but the current data structure and content of the geographic databases would be redesigned

SCENARIO 3:

The **functionality** of the geographic databases would be **migrated to a commercially available GIS product or suite of products.**

- ✓ Design a new database to meet all geographic support system functions using a commercial GIS
- ✓ Customize GIS functions to meet the geographic support needs of the Bureau

Five Objectives for the MAF/TIGER Enhancements Program (MTEP)



OBJECTIVE 3:

Expand and encourage geographic partnership programs

WHY?

- Census Address List Improvement Act of 1994 (Public Law 103-420)
- Experience in the 2000 Census
- Duplication of effort
- Lack of funds / coordination of funds and resources

Obj. 3 Expand and Encourage Geographic Partnerships

Partnering at all levels . . .



- **Devise/deploy new strategies to communicate more effectively with state/local/tribal governments**
to increase the level at which they participate in address list review, street update, and boundary reporting activities.
- **Devise/deploy new ways in which to integrate more effectively**
the address list review, street update, and boundary reporting activities
that now exist as separate programs.
- **Establish new partnerships with other federal agencies and private sector firms**
that have GIS and address files that can be used to improve the currency
and coverage of MAF/TIGER.

Obj. 3 Expand and Encourage Geographic Partnerships

Types of partnerships...



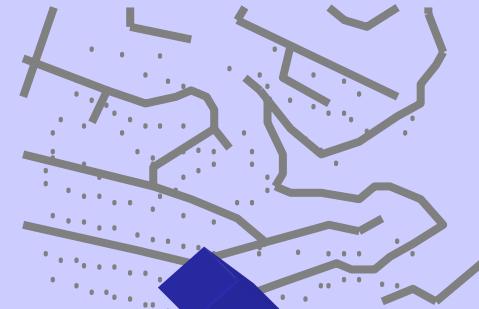
Funds vs. In-Kind services



from Provider



back to Provider



Census processing

Obj. 3 Expand and Encourage Geographic Partnerships

Types of partnerships...



National Digital Orthophoto Program (NDOP)

- states are looking for partnerships soon, and the Bureau monies for imagery may not be available for several years
- very little state imagery data comes from a satellite; nearly all is from aerial imagery

Implementation Team

- Participation in state level I-Teams
- Focus and align agency efforts in support of I-Teams
- Work together to align spatial data investments and resources

Local GIS Files

- first choice strategy for locational accuracy if possible (Objective 1)
- current information suggests 1/3 of all counties

Obj. 3 Expand and Encourage Geographic Partnerships

Types of partnerships...



Boundary and Annexation Survey (BAS)

- development of electronic data interchange – submission by computer file rather than paper maps and forms
- accommodate electronic extracts; as well as, updates supplied manually

Local Update of Census Addresses 1 (LUCA 1)

- continuous or “rolling” LUCA program
- geographic partner to access the Bureau’s information for review purposes and any updates would be communicated to the Bureau

Local Update of Census Addresses 2 (LUCA 2)

- continuous or “rolling” LUCA program
- geographic partner to access the Bureau’s information for review purposes and update LUCA-related data through a Web application.

Five Objectives for the MAF/TIGER Enhancements Program (MTEP)



OBJECTIVE 4:

Launch the American Community Survey Coverage

➤ **Focus on predominately rural areas**

in which the U.S. Postal Service's Delivery Sequence File (DSF) does not effectively identify the existence or location of new housing units.

➤ **Provide address list (and street) updates beyond what can be identified through the current twice-yearly DSF "refresh" process**

to ensure a uniformly accurate MAF/TIGER sampling frame nationwide for the ACS and the other household surveys.

Obj. 4 American Community Survey Coverage

Updating MAF/TIGER Without the DSF



The Census Bureau is developing portable systems that will provide field staff with the tools they need to find new development and update MAF/TIGER with new addresses and new streets.

This will be especially useful for areas that are not willing (or able) to participate in a “LUCA-like” MAF/TIGER review and update process



Five Objectives for the MAF/TIGER Enhancements Program (MTEP)



OBJECTIVE 5:

Implement periodic evaluation activities

➤ **Comprehensive Quality**

Provide quality metrics information that will guide (target) areas in need of corrective action beyond the changes identified in the Change detection (objective 1) and CAUS (objective 4) activities.

➤ **Product Quality**

Document the progress being made to improve the location and completeness accuracy of MAF/TIGER.

Develop a plan to assure the availability of accurate and comprehensive metadata about MAF/TIGER data.

➤ **Field Verification**

Propose to complete a physical verification of data stored in the various geographic databases for a representative sample of 500,000 housing units.

Five Objectives for the MAF/TIGER Enhancements Program (MTEP)



1. **Correct the locations** of streets and other map features (in TIGER);
Correct the locations of housing units (in the MAF);
Implement automated **change detection** method.
2. Develop/deploy a new MAF/TIGER processing environment based on **COTS** and **GIS** tools
3. Expand and encourage **geographic partnership programs** with state, local and tribal governments, other federal agencies, and the private sector
4. Implement the **American Community Survey Coverage Program**, primarily for rural areas, to ensure a complete and accurate MAF/TIGER nationwide
5. Implement **periodic evaluation activities** to provide quality metrics, and to guide corrective actions needed to foster a fully effective national geocoding system

What Have We Done So Far?

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)



• **Learned from the ITS088 Contract**

September 2000 thru May 2002

A research and development initiative allowing the Bureau to determine:

- The usefulness and cost of differing types of imagery
- The state of automated vector extraction
- The ability of industry to correlate extracted vectors to existing TIGER/Line feature

Provided a much better understanding of the “state of the industry”

- feature extraction technologies
- feature matching capabilities

Improved our knowledge of imagery and other space-based source materials

- the potential applicability of each type of OUR specific problem
- beyond the pretty pictures, the need to check returned files for “problems

What Have We Done So Far?

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)



• **Learned from the ITS088 Contract (cont.)**

Reinforced the need for realistic delivery schedules and holding to them

Identified the importance of the contractor's approach to staffing

- stable staff vs. frequent staff turnover

Some potential "pitfall" areas

- tasks we believed would be easy were very difficult for contractors
- tasks we believed would be hard proved easy

The Magnitude of our task

- how much effort is required to support production operations
- how much easier it is to work with state/local/tribal GIS files

What Have We Done So Far?

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)



• **Learned from the ITS088 Contract (cont.)**

The importance of risk management and risk mitigation

- The only way to mitigate our “failure to complete by 2008” risk is to start now and assure approval of requested funding level each FY
- Delays in funding will cause “pile-up” of counties in later years, exceeding operational capacity.

Provided the contractors with an appreciation for the intricacies of Census Bureau geography, MAF/TIGER, and our requirements

- experience in producing files in our format (what it does and doesn't do)
- File formatting is easier said than done
- “Census topology” is a complex subset of topology with very rigorous set of rules
- the importance of understanding our specifications (adequate development time essential, stable specifications, and change control are integral)
- the importance of developing a “common language” (you say “topology”, I mean “census topology”)
- the importance of communication

What Have We Done So Far?

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)



- Learned from the ITS088 Contract (cont.)

PARTNERSHIP is **GOLDEN**

- Harris Corporation was a productive partner in ITS088;
and will not require a new “learning curve”

What Have We Done So Far?

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)



- **MTAIP Contract**

Signed by the Census Bureau/Harris Corporation of
Melbourne, FL on June 25, 2002 -- three days ahead of schedule

Phase 1 - Planning

Expected completion date: December 18th, 2002

Phase 2 - Production

Began January 2003

What Have We Done So Far?

Obj. 1 MAF/TIGER Accuracy Improvement Project (MTAIP)



- **Upload/Acceptance
Quality Assurance Contract
(Not part of MTAIP Contract)**

Geo-Serv -- an SBA-certified “super” 8A contractor, a subsidiary of the Arctic Slope Regional Corporation

Tasks

- Create an inventory of private and public data sources
- Define criteria for accuracy, currency, and change detection
- Perform MAF/TIGER upload process
- Evaluate potential change detection technologies

What Have We Done So Far?

Obj. 2 Modern MAF/TIGER Processing Environment



- **Task Statement of Work:**

Released for contractor bid in December 2002

Purpose is to acquire contractor support for the Bureau's development of a modern geographic data processing environment

Tasks include:

- Document existing software
- Requirements analysis
- Documentation of database design
- System architecture development and documentation
- Provide consultation on object oriented design & software development, and
- Design & develop system backup and maintenance plans

What Have We Done So Far?

Obj. 2 Modern MAF/TIGER Processing Environment



- **Staff Training**

 - COTS/GIS software,

 - Software engineering

 - Project management

- **Developed Requirements and “model” of current objects, behaviors, and attributes**
- **Conducted market research on databases and prototype data models**

What Have We Done So Far?

Obj. 3 Expand and Encourage Geographic Partnerships



- **USGS and BOC**

- Investigating the use of IFSAR (radar)
- Census Bureau has consultant reviewing the IFSAR data for a selected county for accuracy and attributes

- **Federal Interagency working groups**

- Building a comprehensive inventory of geospatial data (TED)
- Census Bureau continues to take the lead in acquiring files
- Standards development

Transportation Framework Data Content Standard

Governmental Unit Boundary Data Exchange Standard

Proposal for Address Content Standard

- **Open GIS Consortium – CIPI 2**

- WebBAS
- Server solution for delivering TIGER data via the Web

What Have We Done So Far?

Obj. 4 American Community Survey Coverage Program



- **Automated Listing and Mapping Instrument**

- November 2002 Testing
- September 2003, Full Production

What Have We Done So Far?

Obj. 5 Periodic Evaluation Activities



What Does the Government Get For Its Money?



- Improved address and map accuracy
- More effective geographic partnerships
- A source for The National Map, Homeland Security, Geospatial One-Stop, and the National Spatial Data Infrastructure
- A major contribution to a more effective/lower cost 2010 Census, ACS, and other household survey operations

What Will MAF/TIGER Be After Enhancement?

Topologically Integrated Geographic Encoding and Referencing



A highly accurate street center-line “digital map” (geographic data base) of the entire United States, Puerto Rico, and the associated Island Areas

TIGER Content (Over Aerial Image)

- Street center-lines and their names
- Lakes, streams, and their names
- Railroads
- Geographic entity boundaries, names, and codes (for governmental units, census tracts, census blocks, etc.)
- Housing unit locations
- Key geographic locations (for airports, schools, etc.)
- ZIP Codes and address ranges (for streets with city-style addresses)




What Will MAF/TIGER Be After Enhancement?

Finding the Correct Housing Unit or Group Quarters (GQ)



In the future, correct locations in MAF/TIGER, and devices equipped with GPS receivers, will provide the tools field staff need to find the correct housing unit/GQ and validate the accuracy of each address

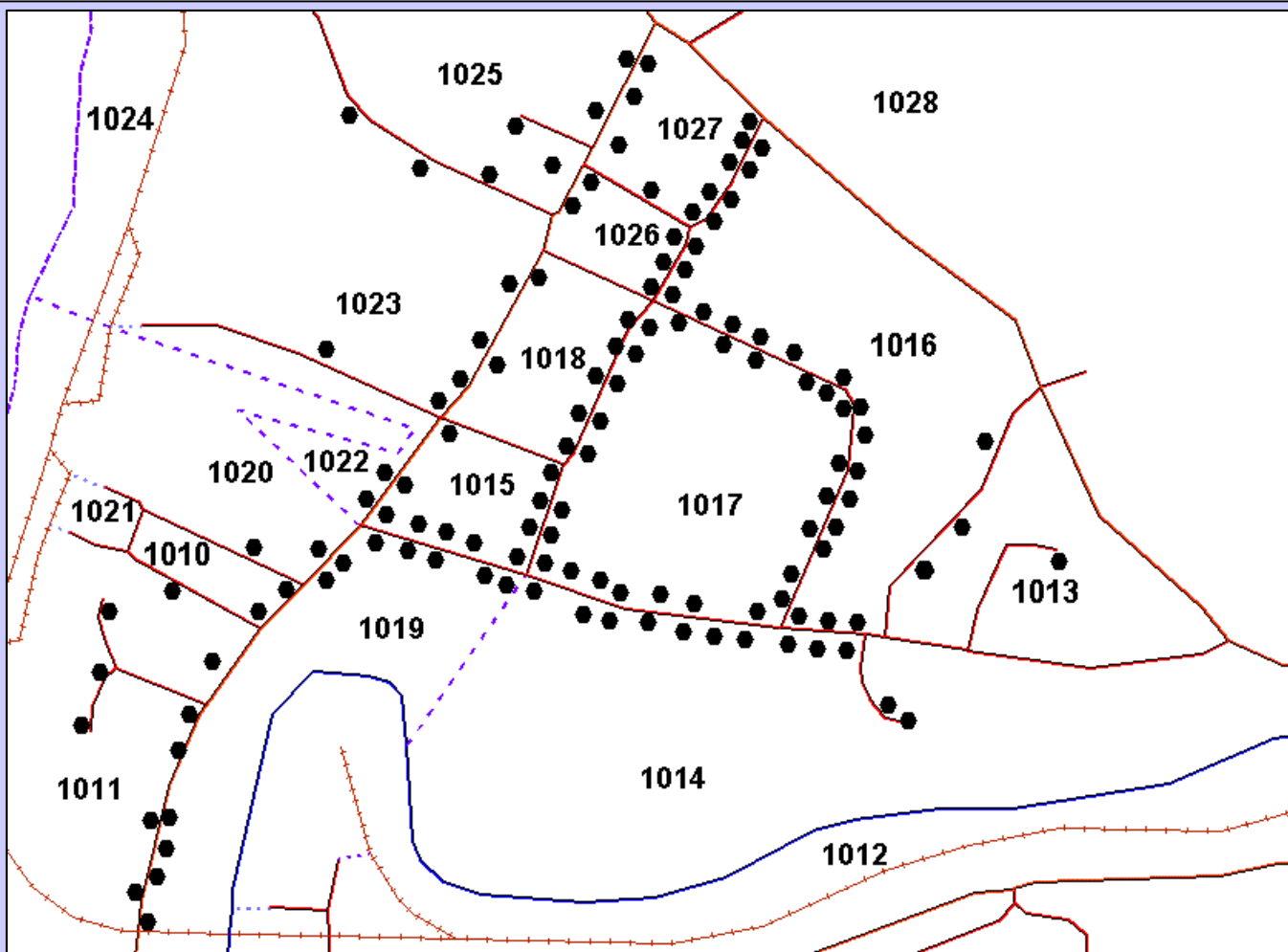


1234 Branch Ave.
Alt. Name: Maryland Rt. 5
County: Prince Georges
City: Clinton
Coords: Latitude N 34° 18' 00"
Longitude W 81° 37' 00"
Tract: 1251
Block: 1071

A handheld GPS device is shown in the foreground, held by a person's hand. The device has a small screen displaying a map with a red dot indicating a location. The device is connected to a larger, open laptop or tablet, which displays the address and coordinates listed in the text box.

What Will MAF/TIGER Be After Enhancement?

Highly accurate MAF/TIGER locations will foster use of GPS locational technology for the American Community Survey and the 2010 Census



Accurate MAF structure locations over correctly located TIGER street centerlines will allow GPS devices to put field staff and houses on the correct side of the street and, therefore, in the correct census block

Thank You



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